EXHAUST MUFFLER

Background of the Invention

The present invention relates to an exhaust muffler for a motor of a handheld, portable power tool such as a motor-driven chain saw, a disc grinder or the like.

An exhaust muffler for a motor of a handheld power tool is known from patent specification DT 25 39 516 A1. The exhaust muffler has a damping chamber in a housing. An inlet opens into the damping chamber and an outlet leads out of the damping chamber.

The underlying objective of the invention is to propose an exhaust muffler of the generic type, which has good sound absorption properties.

This objective is achieved by an exhaust muffler having a muffler housing that encloses at least one damping chamber and has an inlet for exhaust gases for the motor and an outlet, wherein a resonator chamber is provided and is closed off so as to be substantially fluid-tight relative to the damping chamber, wherein a resonance pipe that conveys exhaust gas is guided through the resonator chamber, and wherein an acoustic link is provided between the resonance pipe and the resonator chamber.

The fact that the resonator chamber is acoustically linked to the resonance pipe secures an additional silencing effect. At the same time, there is essentially no flow of fluid from the resonance pipe into the resonator chamber. The resonator chamber absorbs particularly high frequencies in the range of from 1000 Hz to approximately 2500 Hz.

The resonance pipe is expediently disposed between the damping chamber and the outlet in the flow direction of the exhaust gases. The exhaust gas temperature in the resonator chamber is therefore relatively low, which means that the resonator chamber can be packed with glass wool, for example. The acoustic link is expediently provided in the form of orifices in the resonance pipe. In order to obtain effective noise absorption, the total surface area of the orifices is approximately 200 mm^2 to 500 mm^2, in particular from 350 mm^2 to 400 mm^2. To make manufacturing easier, the orifices are circular in shape. The diameter of the orifices is expediently between 1 mm and 4 mm, in particular approximately 2 mm. Good noise-absorbing properties are obtained if the resonance pipe has 100 to 150, in particular approximately 120, orifices leading to the resonator chamber.

The resonance pipe in the resonator chamber expediently runs in a bent arrangement. In particular, the end of the resonance pipe remote from the damping chamber forms the outlet. The exhaust gases therefore leave the muffler after flowing through the resonance pipe. The resonator chamber constitutes the last stage of noise absorption. Good noise absorption is achieved as a result. This is also a simple way of providing the outlet. The inlet and outlet are arranged more or less opposite one another. The muffler housing is expediently made from two half-shells, namely a bottom shell incorporating the inlet and a top shell. The exhaust muffler can be easily manufactured with few parts due to the fact that the resonator chamber is

provided in the form of a resonator chamber shell, which has a flow connection to a half-shell of the muffler housing, in particular the top shell. The connection is expediently brazed to render it fluid-tight.

The end of the resonance pipe directed towards the damping chamber is disposed at a distance from the resonator chamber. Before reaching the resonator chamber, the exhaust gases therefore have to pass along a specific path in the resonance pipe. This further improves the noise-absorption properties. The distance is expediently at least 30% of the height of the muffler housing, so that the height constitutes the greater part of the muffler housing extension in the joining plane of the two half-shells. Having an approximately rectangular cross section in the joining plane, the height is therefore the longer side of the rectangle. The length of resonance pipe projecting into the damping chamber advantageously extends substantially parallel with the joining plane of the two half-shells, the longitudinal mid-axis of the resonance pipe specifically extending substantially in the direction of the height of the exhaust muffler. Exhaust gases are therefore unable to flow into the resonance pipe until they have passed through the damping chamber. Furthermore, the flow must change direction before flowing into the resonance pipe. The resonator chamber is expediently disposed inside the muffler housing. The mounting space needed for an exhaust muffler with resonator chamber is therefore no different from the mounting space needed

for an exhaust muffler with no resonator chamber. Incorporating the resonator chamber improves noise absorption while requiring no extra mounting space. To obtain efficient noise-absorption properties, the resonator chamber is also packed with glass fiber, in particular glass wool.

The muffler advantageously has two damping chambers, which are separated from one another by a dividing wall, a catalytic converter being provided in the dividing wall. The resonator chamber is advantageously disposed in the damping chamber downstream in the flow direction of the exhaust gases.

Brief Description of the Drawings

An embodiment of the invention will be described as an example below with reference to the appended drawings. Of these:

Figs. 1-3 are perspective views of an exhaust muffler,

Fig. 4 is an exploded diagram of the exhaust muffler illustrated in Figs. 1 to 3,

Fig. 5 is a side view of the exhaust muffler illustrated in Figs. 1 to 3,

Fig. 6 is a section taken along line VI-VI in Fig. 5,

Fig. 7 is a section taken along line VII-VII in Fig. 5,

Fig. 8 is a section taken along line VIII-VIII in Fig. 6,

Fig. 9 is a side view of the resonance pipe of the muffler illustrated in

Figs. 1 to 8 in the direction of arrow IX in Fig. 10,

Fig. 10 is a side view of the resonance pipe of the exhaust muffler illustrated in Figs. 1 to 8, and

Fig. 11 is a side view of the resonance pipe in the direction of arrow XI in Fig. 10.

The exhaust muffler 1 illustrated in the perspective diagrams of Figs. 1 to 3 has a muffler housing 2 into which an inlet 3 leads. The inlet 3 is provided in the form of a substantially rectangular orifice and opens into the damping chamber 5 illustrated in Fig. 6. Fixing or mounting orifices 28 are provided on either side of the inlet 3, by which the exhaust muffler 1 is attached to a motor, in particular a motor of a handheld portable power tool such as a motor-driven chain saw or a disc grinder. A tubular outlet 4 leads out of the exhaust muffler 1. The muffler housing 2 is essentially made from two half-shells. The bottom shell 10, directed towards the motor and incorporating the inlet 3, has two reinforcing beads 24 extending substantially parallel. The top shell 9 is remote from the motor and has a cruciform reinforcing bead 25, which lies more or less opposite the two parallel reinforcing beads 24. The two half-shells 9, 10 are joined to one another at their rims 14, 13, the rim 13 of the bottom shell 10 being turned over in a bead to engage around the rim 14 of the top shell 9.

As may be seen from the exploded diagram shown in Fig. 4, a peripheral gasket 12 is provided between the rims 13, 14. Disposed inside the muffler housing 2 is a resonator chamber shell 11, through which a resonance pipe 7 leads. Sleeves or tubes 15 are inserted through the muffler housing 2 at either side of the resonance pipe 7 and have a widened rim 29 at their end directed towards the top shell 9. Both the top shell 9 and the bottom shell 10 have lateral raised areas 30 extending substantially perpendicular to the rims 13, 14 of the half-shells, increasing their strength. The resonator chamber shell 11 has a peripheral rim 31, by which it is secured to the top shell 9. The resonator chamber shell 11 has an orifice 32, the contour of which matches the external contour of the resonance pipe 7.

As may be seen more particularly from the section illustrated in Fig. 6, a part of the longitudinal extension of the resonance pipe 7 is disposed inside the resonator chamber 6 formed in the resonator chamber shell 11. The resonator chamber shell 11 is sealed off from the damping chamber 5 formed in the muffler housing 2 so as to be fluid-tight. The resonator chamber shell is closed off by the top shell 9. To this end, the rim 31 of the resonator chamber shell 11 is joined to the top shell by brazing. For practical purposes, however, other types of joints could be used. In the region of the resonator chamber 6, the resonance pipe 7 has a plurality of orifices 8 providing an acoustic link

between the interior of the resonance pipe 7 and the resonator chamber 6. The volume of the resonator chamber 6 is smaller, in particular significantly smaller, than that of the damping chamber 5. The volume of the resonator chamber 6 is advantageously a fraction of the volume of the damping chamber 5.

The resonance pipe 7 projects out of the resonator chamber 6 into the damping chamber 5. The end 18 of the resonance pipe 7 disposed in the damping chamber 5 therefore sits at a distance a from the resonator chamber shell 11. The distance a is expediently at least 30% of the height h indicated in Fig. 5. The height h is the bigger extension of the exhaust muffler 1 in the joining plane 23 of the half-shells 9 and 10. In terms of the substantially rectangular cross section of the muffler housing 2 in the joining plane 23, the height h constitutes the long side of a rectangle delineating the cross section. The run 22 of the resonance pipe 7 lying in the damping chamber 5 outside of the resonator chamber 6 is fixed by means of the web or stay 17 spot-welded onto the top shell 9. The web 17 is brazed onto the end 18 of the resonance pipe 7 projecting into the interior of the muffler housing 2. The longitudinal mid-axis 21 in the run 22 extends substantially parallel with the joining plane 23, in particular substantially in the direction of the height h. The resonance pipe 7 constitutes the outlet 4 from the exhaust muffler 1. The resonance pipe 7 extends in a bent arrangement inside the resonator chamber 6. A pull-

through piece or passage 16 is formed in the top shell 9, through which the resonance pipe 7 leads. Relative to a line 33 perpendicular to the joining plane 23, the longitudinal mid-axis 21 of the resonance pipe 7 at the outlet 4 is inclined at an angle β, which is expediently in the range of between 5□ and approximately 20 . However, it may also be expedient to provide a different angle of inclination. The longitudinal mid-axis 21 intersects with the top shell 9 in the region of the outlet 4 at a distance e from the longitudinal mid-axis 34 of the tubes 15, simultaneously constituting the mid-axis of the inlet 3, which is expediently in the range of from 20 mm to 40 mm.

As illustrated in Fig. 5, a tab 19 is provided at the rims 13, 14 of the half-shells 9, 10 and has a central fixing or mounting orifice 20. The width b of the exhaust muffler 1 as measured in the joining plane 23 is smaller than the height h. When a power tool is disposed in the normal operating position, the height h extends in the vertical direction in the standard assembled position.

As may be seen from the section illustrated in Fig. 7, the longitudinal mid-axis 34 of the tubes 15 forms an angle α with the line 33 perpendicular to the joining plane 23 which may be between 5° and 40°, in particular approximately between 20° and 30°. The reinforcing beads 24 are provided in the form of raised areas and the reinforcing bead 25 as a recess. The inlet 3 as well as the orifices 28 disposed on either side of the inlet 3 are at a distance c from the joining plane 23 is expediently in the range of between 30

mm and 60 mm. As may also be seen from the section illustrated in Fig. 8, the tubes 15 are pushed from the top shell 9 out through pull-through pieces or passages 27 in the top shell 9. At their end directed towards the bottom shell 10, the tubes 15 have a shoulder 35, which sits on a reinforcing element 26. The reinforcing element 26 is therefore disposed between the bottom shell 10 and the shoulder 35 of the tube 15. The reinforcing element 26 prevents the bottom shell 10 from being torn out in the region of the fixing. In order to secure the exhaust muffler 1 to a motor, it is screwed to the motor by means of screws, which are pushed through the tubes 15 and project through orifices in the reinforcing elements 26. In the region of the top shell 9, the tubes 15 have a rim 29, which abuts with the pull-through piece 27 and retains the tube 15. The tube 15 is expediently secured to the top shell 9 by additional means.

Figs. 9 to 11 illustrate the resonance pipe 7. The resonance pipe 7 has lateral rims or edges 36, which lie substantially diametrically opposite one another. The rims 36 extend from the end 18 of the resonance pipe 7 disposed in the damping chamber 5 as far as the point at which the resonance pipe 7 leaves the resonator chamber 6. The terminal edges 37 of the rims 36 sit against the internal face of the top shell 9. The position of the resonance pipe 7 is fixed as a result. The rims 36 have a half width f, which may be in the range of from 0.3 mm to 1.5 mm. In the region of the resonator chamber 6, the resonance pipe 7 has a plurality of orifices 8. The orifices 8

are circular in shape and have a diameter d in the range of from 1 mm to 4 mm and in particular approximately 2 mm. The resonance pipe 7 advantageously has approximately 100 to 150, in particular about 120 orifices 8. The total surface area of the orifices 8 is expediently 200 mm^2 to 500 mm^2, in particular 350 mm^2 to 400 mm^2. The orifices 8 provide an acoustic link between the resonance pipe 7 and the resonator chamber 6. In order to obtain efficient absorption or dampening, the resonator chamber 6 is completely filled with glass fibers, in particular glass wool, or with some other sound-absorbing material.

It may be of advantage to split the damping chamber 5 into two damping chambers. To this end, a dividing wall extends in particular in the joining plane 23. A catalytic converter may be provided in the dividing wall. Instead of the circular orifices, it would also be possible to provide other acoustic links between the interior of the resonance pipe and the resonator chamber. The resonator chamber may also be arranged externally to the muffler housing 2. It might be of advantage to arrange the resonator chamber in the region of the outlet, although it may also be expedient to arrange the resonator chamber in the region of the inlet to the exhaust muffler.

The invention may advantageously be used in conjunction with low capacity motors in the range of approximately 20 cm^3 to approximately 250 cm^3 piston displacement.

The specification incorporates by reference the disclosure of German priority document 102 35 408.1 filed August 2, 2002.

The present invention is, of course, in no way restricted to the specific disclosure of the specification and drawings, but also encompasses any modifications within the scope of the appended claims.